**3GPP TSG-RAN WG4 Meeting # 98-bis-e R4-210XXXX**

**Electronic Meeting, Apr. 12 - 20, 2021**

**Agenda item:** 8.3.4

**Source:** Moderator (Apple)

**Title:** Email discussion summary for [98-bis-e][132] NR\_RF\_FR2\_req\_enh2\_Part\_3

**Document for:** Information

# Introduction

The scope of Phase 1 and 2 in WID are specified as follow

* UL gaps for self-calibration and monitoring. [RAN4 RF/RRM, RAN2] Study and, if feasible, introduce UE specific and NW configured gap for general self-calibration and monitoring purposes including
  + - PA efficiency and power consumption
    - Transceiver calibration due to temperature variation
    - UE Tx power management
    - Others self-calibration and monitoring are not precluded
  + **Phase 1:** Study and clearly identify the performance gain over the current baseline (Rel.16 requirements) Study of RF performance evaluation/testability related to UE self-calibration and monitoring. Study network impact of UE emissions during UL gap, if any.
  + **Phase 2:** Specify the UL gap configuration(s), related UE capability and interruptions, if needed, based on the identified performance gain in Phase 1 and UE fall back behaviour i.e. if gaps are not available for UE requesting gaps.

In RAN4#98e, a WF on UL gap (R4-2103114) has been agreed that

* + UL gap-based UE power/UL coverage gain with proximity sensing has been shown with respect to R16 amount of P-MPR for UEs without the use of such gaps. However, how to show the gain in the test is FFS
  + For PA and transceiver calibration use cases, the metrics for performance gain can be UE TX power increase and DL throughput increase.
    - FFS: additional metrics for consideration can be IBE reduction.
  + Companies are encouraged to provide network impact analysis with the above evaluation assumptions
  + Requirements associated with UL gap:
    - All the UE RF requirements should be applicable if any type of gaps is defined and allowed for the UE.
    - New requirements if identified can be discussed in phase II
    - UE TX power and DL throughput

# Topic #1: Study and identify the performance gain, evaluation and NW impact of UL gap

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2104526**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104526.zip) | vivo | **Observation 1:** PA calibration can improve the performance of mmWave system significantly by reducing the non-linearity of component.  **Proposal 1:** The performance metric for PA calibration can be MPR, EVM and ACLR.  **Observation 2:** The performance gain of PA calibration without feedback may influenced by the power of Tx chain.  **Observation 3:** Behavior 2 of Type 2 gap have more restriction, which will affect the actual gain from calibration.  **Proposal 3:** The 1-layer transmission behavior during the gap should not be considered.  **Proposal 4:** The length of the UL gap should be long enough to ensure that each Tx can alternately complete the calibration. |
| [**R4-2104610**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104610.zip) | CMCC | **Observation 1: At current stage, we have two options on how to show the system-level performance gain. One is by testing, taking the calibration as the black box and the other is to do the analysis step by step. At first analyse how much device-level improvement e.g. IQ image rejection and then calculate corresponding system-level performance gain e.g. UL Tx power.**  **Proposal 1: to better understand how the performance gain is performed, it is suggested to show how much improvement of device-level improvement when perform UL gap, e.g. IQ image rejection, LO leakage. Then analyse the final system-level performance gain, e.g. the UL Tx power and DL throughput.**  **Proposal 2: it is suggested to show the gap duration and calibration periodicity when evaluate performance gain to reflect UE calibration characteristics and then help define final gap configuration.**  **Proposal 3: UL gap may be optional not mandatory if net performance gain is verified only for part of testing UE not all the UE.**  **Proposal 4: IBE related requirements are still needed to directly reflect PA/transceiver characteristics after the UL gap calibration considering in some cases the calibration could only improve the IBE not the UL Tx power.** |
| [**R4-2104849**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104849.zip) | Apple | **Observation 1: Significant impact to UL range is observed as a function of P-MPR.**  **Observation 2: Overall higher network capacity with minimum system impact is expected to enable UL gap.**  **Proposal 1: Introduce type-1 UE specific and NW configured gap for Tx power management.**  **Proposal 2: Potential test cases can be added to measure delta EIRP between the cases UL gap is activated and deactivated.**  **Proposal 3: Procedure to apply P-MPR specified in 38.101-2 can be reused.**  **Proposal 4: RAN4 should conclude Phase I and move forward to Phase II discussion from RAN4#99e.** |
| [**R4-2104920**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104920.zip) | ZTE Corporation | **Observation 1: For Type 2 UL gap, considering the UL gap configuration should be UE-specific, so the impact of UL scheduling limitation should be multipled by the number of UEs.**  **Observation 2: Not only transmission opportunity loss, but also HARQ-ACK feedback postponement, the two impacts caused by UL gap will deteriorate the system performance.**  **Proposal 1: For Type 1 UL gap, RAN4 needs to check whether transmit off power requirement can be satisfied.**  **Proposal 2: In order to convert the gain of self-calibration into spectrum efficiency improvement, New requirements or additional signaling mechanism should be introduced to reflect or indicate the gain of self-calibration. But both will lead to large workload.** |
| [**R4-2105089**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2105089.zip) | Ericsson, Sony | * **Provide some more background on why autonomous measurements or parallel proximity measurements can’t be done to reduce P-MPR** * **How frequent in time are gaps needed (periodicity)?** * **How long are the gaps?** * **Given 2) and 3) what is the expected end user gain in forms of throughput and coverage** * **Note that the scheduling possibility/impact will be affected also outside the time window of the gaps indicated in bullet 3.** * **Proposal 1: Provide feedback on the 4 first bullets stated in clause 2.** |
| [**R4-2106396**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106396.zip) | Nokia, Nokia Shanghai Bell | **Observation 1:** UL gaps with a periodicity of 5% correspond to 1 slot every 2.5 ms which may have be a significant impact in system level performance. Instead, MPE power back-off is averaged over few seconds.  **Observation 2:** In order to save space and cost, reusing the antenna array as a radar has a clear advantage. However, user detection at a few cm away from the array may require a very large bandwidth (e.g. 1 GHz) as well as a high sampling rate.  **Observation 3:** With accurate user detection and distance estimation, the UE can dynamically adjust P-MPR for MPE compliance according to user distance detection.  **Observation 4:** The UE configured with UL gaps for proximity detection must also show P-MPR improvement depending on distance of object/user.  **Observation 5:** To enable radar operation to detect users, the array must be designed to provide enough isolation between transmitted and received signal (e.g. about 50 dB).  **Observation 6:** Only if enough bandwidth is allocated to the UE and if the UE can guarantee isolation in its Rx chain for full-duplex operation, some level of detection while reusing the Tx signal could be envisioned, thereby decreasing the need for UL gaps.  **Proposal 1:** Introduce a peak EIRP metric to show the performance gain from PA and transceiver calibration resulting from the introduction of UL gaps.  **Proposal 2:** Define improved peak EIRP requirements for PC3 UEs using similar power boosting as in FR1 (e.g. Boosting of 3-5 dB) when UL gaps used for PA/TRX calibration.  **Proposal 3:** Introduce a requirement P-MPR reduction in MPE scenarios to show the performance gain resulting from the introduction of UL gaps for proximity detection.  **Proposal 4:** Based on the analysis on system level performance of the periodicity of UL gaps as well as the need for MPE P-MPR adjustments, it would be beneficial reduce the periodicity to e.g. 0.05% - 0.125% interval, which corresponds to 250 ms - 100 ms interval.  **Proposal 5:** Introduce mandatory P-MPR reporting under MPE events for UEs configured with UL gaps for proximity detection, to show P-MPR improvement resulting from UL gap configuration to reveal user/object presence.  **Proposal 6:** Introduce a requirement difference on P-MPR reduction depending on proximity sensor triggering distance. |
| [**R4-2107034**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107034.zip) | NTT DOCOMO INC. | **Observation 1: For UL gap feature, there seems a trade-off relationship between UL performance improvement and negative effects such as scheduling constraints and throughput degradation.**  **Observation 2: Given that there seems the trade-off relationship between UL coverage enhancement and some negative effects, whether the UL gap feature is effective or not will depend on area characteristics.**  **Observation 3: Regarding a treatment of legacy BS(s), if BS(s) need to conduct special scheduling for the UL gap feature, UE with the UL gap feature cannot work well under legacy BS(s).**  **Observation 4: A mutual signalling method using one-bit RRC flag from BS(s) and capability from UE(s) can address possible problems on NW deployment described in observation 2 and 3.**  **Proposal: Introduce a mutual signalling method using one-bit RRC flag from BS(s) and capability from UE(s) for the UL gap feature.**   * **Introduce a new IE and a UE capability for the UL gap feature** * **The necessity of introduction of this method can be discussed separately for type 1 and type 2 gaps.** |
| [**R4-2107267**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107267.zip) | Huawei, HiSilicon | ***Observation 1: For coherent UL MIMO, RAN1/RAN2 and RAN4 spec are not aligned on preconditions that UE can support the feature. The preconditions that UE can support coherent UL MIMO in TS 38.101-2 are not avoidable in a real communication, which makes coherent UL MIMO only paperwork.***  ***Observation 2: Configured UL gap can help UE to maintain the coherence between antenna ports for the upcoming PUSCH transmission with coherent codebook.***  ***Observation 3: the average Coherent UL gap related performance gain is larger than 30%. The most important issue is, coherence calibration makes UL coherent MIMO feature into the field usage.***  ***Observation 4: for UL calibration gap for coherent UL MIMO, UE can use the transmission signal for calibration, it has following advantages:***   * ***Compared non-coherent UL MIMO codebook set, coherent UL MIMO can increase network performance by 30% and even higher.*** * ***It does not have impact on network scheduling.***   ***Observation 5: for coherence calibration UL gap, we can take relative phase/power error requirement with switching/port change side condition as the Requirements and associated test.***  ***Proposal: RAN4 agrees to study UL calibration gap for coherent UL MIMO, the objective is added into the FR2 RF enh2 WID.*** |
| [**R4-2107269**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107269.zip) | HiSilicon Technologies Co. Ltd | ***Observation 1: Other than output power boost, transceiver calibration with UL gap can be verified by LO leakage and IQ image requirements improvement.***  ***Observation 2: Transceiver calibration can solve the big overhead on DC location reporting signalling, LO leakage and image eliminating can improve the network performance by more flexible scheduling.***  ***Proposal 1: RAN4 confirms the performance gain brought by transceiver calibration gap, and take IBE RF requirement as the target requirement and test case.***  ***Observation 3: UE is better to be informed of the scheduled operating frequency, instant bandwidth, and transmission power before calibration. The gap period can be largely reduced if transmission information(usually by DCI) is transferred to the UE in advance.***  ***Observation 4: Transceiver calibration use type 1 gap (No UL scheduling during the gap is needed), while generally off power requirement in channel should be met during the gap period:***   * ***Whether there could be exception need further evaluation in RAN4***   ***Proposal 2: Transceiver calibration use type 1 gap, scheduling information is already known by UE during the gap.***  ***Proposal 3: generally off power requirement should be met during the gap period for transceiver calibration, whether there is exception case FFS.*** |
| [**R4-2107279**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107279.zip) | Qualcomm Incorporated | **Observation 1: Benefit of potentially smaller P-MPR for UE’s which utilize UL gaps is only applicable for the UE’s that implement mmW proximity detector and need the detection to be enabled by the network**  **Observation 2: P-MPR based benefit is not a testable performance gain within the scope of this WID**  And made the following proposals  **Proposal 1: If UE which needs UL gaps is not scheduled the UL gaps, UE shall fall back to Rel-16 behaviour and conform to Rel-16 requirements​**  **Proposal 2: Min Peak EIRP is increased by 2 dB when calibration gaps are provided**  **Proposal 3: MPR for 64 QAM is decreased by 1.5 dB for Inner allocations for PC3 for the UE when cal gaps are provided.** |
| [**R4-2107280**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107280.zip) | Qualcomm Incorporated | **Proposal 1: The definitions of the gaps are**  **Active transmission gap: UE is scheduled for UL resources which it can use to its own internal self calibration. UE may transmit signals occupying defined resources and shall conform to emission requirements**  **Silent gap: UE is not assumed to transmit or receive during scheduled resources. UE conforms to the OFF power requirements**  **Proposal 2: UE declares the need for each type of the gap**  On when and where the gap should be applied, we made one more proposal:  **Proposal 3: This feature should be optional and network impact confined to the UE’s which support this capability** |

## Observation summary based on the contributions

* On performance evaluations and metric over the baseline in R16
* UE power/coverage enhancement
  + Evaluation metric:
    - Apple: delta EIRP performance between with and without UL gap
  + Performance gain
    - Apple: Throughput gain analysis based on different Tx power gain and gap overhead, for DDDSU configuration

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Gap overhead | 0.625% | 1.25% | 1.875% | 2.5% | 3.125% | 3.75% | 4.375% | 5% |
| 3dB Tx power gain | 32.71% | 28.42% | 24.14% | 19.86% | 15.58% | 11.30% | 7.02% | 2.74% |
| 4dB Tx power gain | 42.46% | 37.87% | 33.27% | 28.68% | 24.08% | 19.49% | 14.89% | 10.29% |
| 5dB Tx power gain | 58.81% | 53.69% | 48.57% | 43.44% | 38.32% | 33.20% | 28.07% | 22.95% |
| 6dB Tx power gain | 86.30% | 80.29% | 74.28% | 68.27% | 62.26% | 56.25% | 50.24% | 44.23% |

* + - Nokia: Introduce a requirement P-MPR reduction in MPE scenarios to show the performance gain resulting from the introduction of UL gaps for proximity detection.
    - Ericsson: what is the expected end user gain in forms of throughput and coverage given UL gap periodicity and the gap length.
    - Qualcomm: Benefit of potentially smaller P-MPR for UE’s which utilize UL gaps is only applicable for the UE’s that implement mmW proximity detector and need the detection to be enabled by the network. P-MPR based benefit is not a testable performance gain within the scope of this WID
  + NW impacts:
    - Nokia: UL gaps with a periodicity of 5% correspond to 1 slot every 2.5 ms which may have be a significant impact in system level performance. Instead, MPE power back-off is averaged over few seconds.
    - ZTE: Not only transmission opportunity loss, but also HARQ-ACK feedback postponement, the two impacts caused by UL gap will deteriorate the system performance.
  + Related requirements/tests
    - CMCC: to better understand how the performance gain is performed, it is suggested to show how much improvement of device-level improvement when perform UL gap, e.g. IQ image rejection, LO leakage. Then analyse the final system-level performance gain, e.g. the UL Tx power and DL throughput.
    - Apple: test cases can be added to measure delta EIRP between the cases UL gap is activated and deactivated.
    - ZTE: For Type 1 UL gap, RAN4 needs to check whether transmit off power requirement can be satisfied.
    - Nokia: Introduce mandatory P-MPR reporting under MPE events for UEs configured with UL gaps for proximity detection, to show P-MPR improvement resulting from UL gap configuration to reveal user/object presence. Introduce a requirement difference on P-MPR reduction depending on proximity sensor triggering distance.
  + Related signalling
    - ZTE: New requirements or additional signaling mechanism should be introduced to reflect or indicate the gain of self-calibration. But both will lead to large workload.
    - NTT DCM: Introduce a mutual signalling method using one-bit RRC flag from BS(s) and capability from UE(s) for the UL gap feature.
  + Others:
    - Nokia: Based on the analysis on system level performance of the periodicity of UL gaps as well as the need for MPE P-MPR adjustments, it would be beneficial reduce the periodicity to e.g. 0.05% - 0.125% interval, which corresponds to 250 ms - 100 ms interval.
    - Ericsson: request some more background on why autonomous measurements or parallel proximity measurements can’t be done to reduce P-MPR
* PA calibration
  + Evaluation metric:
    - vivo: MPR, EVM and ACLR.
    - CMCC: IBE related requirements
    - Nokia: peak EIRP
  + Performance gain
    - vivo: The performance gain of PA calibration without feedback may influenced by the power of Tx chain.
    - Nokia: Introduce a peak EIRP metric to show the performance gain
  + NW impacts:
    - ZTE: : For Type 2 UL gap, considering the UL gap configuration should be UE-specific, so the impact of UL scheduling limitation should be multipled by the number of UEs. Not only transmission opportunity loss, but also HARQ-ACK feedback postponement, the two impacts caused by UL gap will deteriorate the system performance.
  + Related requirements/tests
    - CMCC: IBE related requirements are still needed to directly reflect PA/transceiver characteristics after the UL gap calibration
    - Nokia: Define improved peak EIRP requirements for PC3 UEs
  + Related signalling
    - ZTE: New requirements or additional signaling mechanism should be introduced to reflect or indicate the gain of self-calibration. But both will lead to large workload.
    - NTT DCM: Introduce a mutual signalling method using one-bit RRC flag from BS(s) and capability from UE(s) for the UL gap feature.
    - Qualcomm: **Min Peak EIRP is increased. MPR for 64 QAM is decreased**
  + Others:
    - vivo: The 1-layer transmission behavior during the gap should not be considered. The length of the UL gap should be long enough to ensure that each Tx can alternately complete the calibration.
    - Ericsson: No further pursue PA calibration related discussion since the majority of the companies have raised concerns on the need of gaps for any PA efficiency or Transceiver calibration.
* Transceiver calibration
  + Evaluation metric:
    - CMCC: IBE related requirements
    - Nokia: peak EIRP
    - Huawei: LO leakage and IQ image requirements improvement.
  + Performance gain
    - Nokia: Introduce a peak EIRP metric to show the performance gain
    - Huawei: Transceiver calibration can solve the big overhead on DC location reporting signalling, LO leakage and image eliminating can improve the network performance by more flexible scheduling.
  + NW impacts:
    - ZTE: Not only transmission opportunity loss, but also HARQ-ACK feedback postponement, the two impacts caused by UL gap will deteriorate the system performance.
  + Related requirements/tests
    - CMCC: IBE related requirements are still needed to directly reflect PA/transceiver characteristics after the UL gap calibration
    - Nokia: Define improved peak EIRP requirements for PC3 UEs
    - Huawei: IBE RF requirement as the target requirement and test case. generally off power requirement should be met during the gap period for transceiver calibration, whether there is exception case FFS.
    - Qualcomm: **Min Peak EIRP is increased. MPR for 64 QAM is decreased**
  + Related signalling
    - ZTE: New requirements or additional signaling mechanism should be introduced to reflect or indicate the gain of self-calibration. But both will lead to large workload.
    - NTT DCM: Introduce a mutual signalling method using one-bit RRC flag from BS(s) and capability from UE(s) for the UL gap feature.
  + Others:
    - vivo: The 1-layer transmission behavior during the gap should not be considered. The length of the UL gap should be long enough to ensure that each Tx can alternately complete the calibration.
    - Ericsson: No further pursue tranceiver calibration related discussion since the majority of the companies have raised concerns on the need of gaps for any PA efficiency or Transceiver calibration.
* Coherent UL MIMO
  + Huawei: it is proposed that RAN4 agrees to study UL calibration gap for coherent UL MIMO, the objective is added into the FR2 RF enh2 WID.
  + Evaluation metric:
    - Huawei: Coherent UL MIMO RF requirement on power imbalance and relative phase error under switch/port change conditions
  + Performance gain:
    - Huawei: Average performance gain between coherent codebook subset and non-coherent codebook subset can be up to 30%.
  + NW impacts:
    - Huawei: *does not have impact on network scheduling*
  + Related requirements/tests
    - Huawei: for coherence calibration UL gap, we can take relative phase/power error requirement with switching/port change side condition as the Requirements and associated test.
* Others
  + Definition of the gaps
    - Qualcomm: The definitions of the gaps are
      * Active transmission gap: UE is scheduled for UL resources which it can use to its own internal self calibration. UE may transmit signals occupying defined resources and shall conform to emission requirements
      * Silent gap: UE is not assumed to transmit or receive during scheduled resources. UE conforms to the OFF power requirements
  + On UE capability:
    - Qualcomm: UE declares the need for each type of the gap

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Usage case** | **Gap type** | **Performance gain** | **Network impact analysis** | **Test cases/Requirement** |
| **Tx power management** | Type 1 | less P-MPR | Overall higher network capacity with minimum system impact is expected | Delta EIRP when P-MRP is applied to meet MPE requirement |
| **Tranceiver calibration** | Type 1 | Less DC reporting signaling.  Potential higher Tx power. | More flexible scheduling. | IBE requirement and test cases |
| **PA calibration** | Type 2 |  | UL grant is needed. | MPR for 64QAM and min peak EIRP |
| **Coherent UL MIMO** | Type 2 or other type | Average coherent UL MIMO gain > 30% | No impact on network scheduling | relative phase/power error requirement with switching/port change side condition as the Requirements and associated test. |

## Open issues summary for the 1st round

UE power/coverage enhancement

* Sub topic 1-1-a: performance gain over the current R16 baseline
* Sub topic 1-1-b: performance evaluation/testability/requirements
* Sub topic 1-1-c: network impact

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1-a:  Sub topic 1-1-b:  Sub topic 1-1-c:  ….  Others: |
| Verizon | Sub topic 1-1-a |
| Ericsson | Sub topic 1-1-a: Perf gain over rel-16 baseline is agreed to our understanding, needs to solve how to define conformance test cases to show the gain. Companies have very different views on this.  Sub topic 1-1-c: NW will be impacted given the 5% gap overhead |
| Apple | Sub topic 1-1-a: Performance gain is observed with less P-MPR compared to R16 UE without proximity sensor. Up to 6dB higher Tx power is expected with 26dBm peak EIRP with 20% UL duty cycle.  Sub topic 1-1-b: Test case can be designed to ensure the UL gap gain. An example test case is provided in the paper. In the UL gap test, UE need to meet MPE requirement all the time during the test and P-MPR >0 should be allowed. UL gap is deactivated during T1 time and activated during T2 time. EIPR is measured separately during T1 and T2 time, and delta EIRP is the test metric.  Sub topic 1-1-c: As presented in our submission, we see significant UL throughout gain and coverage improvement.  Assume no network scheduling constraint, the gap can be scheduled to other UEs. There is no waste of network resource.  Assume the worst-case scheduling constraint, i.e., the UL gap cannot be scheduled to any other UEs, and the UL gap is pure overhead. In this scenario, we still see up to 200% cell edge UE throughput gain with P-MPR=6dB and 0.625% of gap overhead. No loss is observed even with worst case of P-MPR = 3dB and 5% UL gap overhead in DDDSU configuration. |
| T-Mobile USA | Sub topic 1-1-a: Performance gain is reportedly significant.  Sub topic 1-1-b: We need to define conformance test cases to show the gain  Sub topic 1-1-c: As presented in Apple’s submission, there is significant UL throughout gain and coverage improvement. Since the gap is optional it seems like the network impact is limited to UEs that can take advantage of it. |
| Qualcomm | Sub topic 1-1-a: Baseline is R16 testable requirements and improvement over written requirements in TS 38.101-2 is used as metric.  Sub topic 1-1-b: We need to define conformance test cases to show the gain with and without UL gaps allocated to the UE that declares the support for this feature.  Sub topic 1-1-c: Network impact shall be positive. In practice any improvement on UE output power is such. |
| AT&T | Sub topic 1-1-a: Performance gain for Tx power (less P-MPR) and throughput is demonstrated. We should be able to define specific core requirements associated with the performance gain.  Sub topic 1-1-b: We need to propose possible test cases that can verify the gain. The example test case proposed by Apple is a good starting point.  Sub topic 1-1-c: We agree with T-Mobile USA comments. |
| Sony | Sub topic 1-1-a: As Rel-16 UE does not apply P-MPR in the conformance test, it is unclear how to identify the performance gain.  Sub topic 1-1-b: Further clarification on how to design the test is needed. It is unclear how to trigger the proximate sensor during the compliance test as there is no body phantom or any surrounding object are involved in the measurement.  Sub topic 1-1-c: It is also unclear if the calibration gap would be necessary in this case. As mentioned by some contributions, proximate sensors to detect users have been implemented in commercial phones that do not require any gap to perform the detection. |
| ZTE | Sub topic 1-1-b: Conformance test cases should be defined to show the gain. If some gain verified, detailed requirement improvements should be discussed, but we think which means large workload.  Sub topic 1-1-c: Not only transmission opportunity loss, but also HARQ-ACK feedback postponement, the two impacts caused by UL gap will deteriorate the system performance. |
| OPPO | Sub topic 1-1-a: performance gain over the current R16 baseline  Gain can be observed especially in reducing PMPR usage. And less PMPR mean larger UL coverage.  Sub topic 1-1-b: performance evaluation/testability/requirements  In our understanding, the conformance testing only need to guarantee that UE is violating emission during gap is enough. And there is no need to testing the gain of introducing gap, since it is quite different for different UE implementations, some gain big others small. Therefore, there is no meaning to test the gain that can be achieved, instead the gain is only used to justify the benefit of this gap. |
| Nokia | Sub topic 1-1-a: Noticeable performance gains in terms of P-MPR is shown to be possible during the study phase. This gain needs to be ensured through UE requirements and test cases.  Sub topic 1-1-b: Introduce requirements and test cases for P-MPR reduction with MPE events to ensure that the performance gains are obtained from the introduction of UL gaps for proximity detection.  Sub topic 1-1-c: UL gaps create constraints to the network scheduler and negative impact on throughput. The amount of gaps needed needs to be in a good balance with the performance gains obtained in terms of P-MPR reduction. For example, considering a frame structure DDDSU in FR2 numerology 3 (i.e. 120 kHz SCS), there are 4 UL slots in 2.5 ms, which yields a: 25 % UL throughput loss with 5% UL gap periodicity and 1.25 % UL throughput loss with a 0.25% UL gap periodicity. |
| NTT DOCOMO, | Sub topic 1-1-a:  Sub topic 1-1-b:  Thank you for proposal.  Question for the proposed test method is that:  P-MPR value is not specified in RAN4 and it is up to UE implementation, so even if we test the difference of P-MPR value between with and without this UL gap, the baseline requirements, i.e., P-MPR without the UL gap is up to UE implementation. How can we confirm the improvement?  Sub topic 1-1-c:  In the paper, there seems two cases, one is no network scheduling constraint, and another is the case where the UL gap cannot be scheduled to any other UEs. This is a big difference. We wonder if it must be better to specify only the case of no network scheduling constraint, but is there any drawback?  If there is a possibility of scheduling constraint and other negative effect, we would like to discuss introduction of the mutual signaling methods that we proposed. |
| vivo | Sub topic 1-1-a: Performance gain of less PMPR has been shown in some paper. However, the analysis seems more theoretical, and We prefer to further show its gain through a test.  Sub topic 1-1-c: The NW impact can be evaluated by throughput, and in our understanding, the impact is mainly related to different gap types rather than the use case. |
| Intel | Sub topic 1-1-a:  For UL Tx power management use case, of course there will be a higher Tx power as a result of less P-MPR in the field. In conformance testing however, P-MPR is already set to zero, which is the maximum increase Tx power would see from this use case (eliminating P-MPR if nothing is detected by proximity sensor). Therefore, this performance gain is already accounted for in our current test.  That being said, as Qualcomm suggested, we can increase our current requirements by an agreed amount for the UEs that support UL gap.  Sub topic 1-1-b:  Perhaps further discussion and clarification is needed. We are trying to understand the benefit of defining an additional test for this use case for delta EIRP when UL gap is on/off. This involves allowing the UE to take P-MPR during testing, having the proximity sensor on and taking measurements without a target. We know P-MPR will be decreased when there is no target, testing this is effectively testing how good the detector is during the gap (this number should be the same as having no gap and P-MPR set to zero, as the measurement is currently done). Beyond this, why do we need to capture the delta?  Unless there is an additional *concurrent* increase in EIRP from having the UL gap (other than the increase coming from reducing P-MPR to 0), this test may not be needed. |
| Huawei, HiSilicon | * Sub topic 1-1-a: performance gain over the current R16 baseline   We can see the benefit by uplink power management calibration.   * Sub topic 1-1-b: performance evaluation/testability/requirements   PMPR reporting in PHR could be one solution for performance evaluation. We would like to simplify the test, it is better to be processed together with RF requirement verification. This can be further discuss in phase 2.   * Sub topic 1-1-c: network impact   Gap is type 1 , the network impact is very limited, we can even further study how to reduce the overhead by User behaviour in phase 2. |

Sub topic 1-2: PA calibration enhancement

* Sub topic 1-2-a: performance gain over the current R16 baseline
* Sub topic 1-2-b: performance evaluation/testability/requirements
* Sub topic 1-2-c: network impact

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-2-a:  Sub topic 1-2-b:  Sub topic 1-2-c:  ….  Others: |
| Verizon | Sub topic 1-2-a |
| Ericsson | Sub topic 1-2-a:  Sub topic 1-2-b:  Sub topic 1-2-c: We assume type 2 gaps is needed for this PA calibration so it will impact NW even more than type 1 since the GAP needs to be scheduled per UE  General comment: As stated in our paper we don’t think gaps for PA/Transceiver calibration is needed and give significant gain (especially given type 2 gaps). In our opinion this calibration can be done autonomously (and is done today). As discussed in rel-15 timeframe.  See also our concern in Sub-topic 1-5. |
| Apple | Sub topic 1-2-a: Lower MPR for high order modulation is expected for PA calibration.  Sub topic 1-2-b: Performance evaluation was done in R15, no additional results provided in R17 so far.   * Sub topic 1-2-c: Unless new results/discussion submitted, we are open to de-prioritize the use case based on R15 discussion. |
| T-Mobile USA | Sub topic 1-2-a: Lower MPR for higher order modulation reported for PC calibration  Sub topic 1-2-b: Performance evaluation was done in R15  Sub topic 1-2-c: We are fine with deprioritization based on Rel-15 discussions |
| Qualcomm | Sub topic 1-2-a: Baseline is R16 testable requirements and improvement over written requirements in TS 38.101-2 is used as metric.  Sub topic 1-2-b: We need to define conformance test cases to show the gain with and without UL gaps allocated to the UE that declares the support for this feature.  Sub topic 1-2-c: Network impact shall be positive. In practice any improvement on UE output power is such. |
| Sony | Sub topic 1-2-a: Reducing the MPR seems a feasible metric to be considered.  Sub topic 1-2-c: The type 2 gap (scheduled) may need to be taken as a baseline when performing PA calibration. The UE may have difficulty meeting the off-power requirement to our understanding. |
| ZTE | Sub topic 1-2-c: Not only transmission opportunity loss, but also HARQ-ACK feedback postponement, the two impacts caused by UL gap will deteriorate the system performance. Especially for type 2 gap. |
| OPPO | Sub topic 1-2-a: performance gain over the current R16 baseline  Gain can be observed in less MPR be used.  Sub topic 1-2-b: performance evaluation/testability/requirements  In our understanding, the conformance testing only need to guarantee that UE is violating emission during gap is enough. And there is no need to testing the gain of introducing gap, since it is quite different for different UE implementations, some gain big others small. Therefore, there is no meaning to test the gain that can be achieved, instead the gain is only used to justify the benefit of this gap. |
| Nokia | Sub topic 1-2-a: We should aim at noticeable UE Tx power improvements and particularly improvements for peak EIRP for PC3 in FR2 as small performance gains would not justify the introduction of UL gaps.  Sub topic 1-2-b: Introduce a clearly improved FR2 peak EIRP requirement to ensure the performance gain from PA and transceiver calibration resulting from the introduction of UL gaps for PA and TRX calibration, e.g. using similar power boosting as in FR1.  Sub topic 1-2-c: In our view only one gap type (Type1) should be defined and all the use cases and UE requirements for UL gaps should use the same gap type. Otherwise, the network complexity increases even further. |
| vivo | Sub topic 1-2-a: The PA calibration can reduce the non-linearity of device, and the MPR, ACLR, EVM can be improved.  Sub topic 1-2-c: Agree with the Ericsson’s view. Type 2 gap is more complicated and the actual gain it can bring is not clear. |

Sub topic 1-3: transceiver calibration

* Sub topic 1-3-a: performance gain over the current R16 baseline
* Sub topic 1-3-b: performance evaluation/testability/requirements
* Sub topic 1-3-c: network impact

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-3-a:  Sub topic 1-3-b:  Sub topic 1-3-c:  ….  Others: |
| Verizon | Sub topic 1-3-a |
| Ericsson | Sub topic 1-2-c: We assume type 2 gaps is needed for this PA calibration so it will impact NW even more than type 1 since the GAP needs to be scheduled per UE  General comment: As stated in our paper we don’t think gaps for PA/Transceiver calibration is needed and give significant gain (especially given type 2 gaps). As discussed in rel-15 timeframe. In our opinion this calibration can be done autonomously (and is done today).  See also our concern in Sub-topic 1-5. |
| Apple | Sub topic 1-3-a: Performance gain of transceiver calibration was shown in R4-2100217 for higher DL throughput and larger UL Tx power gain.  Sub topic 1-3-b: UL Tx power improvement and DL throughout as agreed as metric for performance gain. We are open to consider additional metric for consideration like IBE reduction.  Sub topic 1-3-c: Type 1 UL gap. The transceiver calibration is mainly to calibrate transceiver performance due to temperature variation. Minimum network impact is expected. |
| T-Mobile USA | Sub topic 1-3-a: Performance gain of transceiver calibration was shown in R4-2100217.  Sub topic 1-3-b: UL Tx power improvement and DL throughout as agreed as metric for performance gain.  Sub topic 1-3-c: Type 1 UL gap. |
| Qualcomm | Sub topic 1-3-a: Baseline is R16 testable requirements and improvement over written requirements in TS 38.101-2 is used as metric.  Sub topic 1-3-b: We need to define conformance test cases to show the gain with and without UL gaps allocated to the UE that declares the support for this feature.  Sub topic 1-3-c: Network impact shall be positive. In practice any improvement on UE output power is such. |
| ZTE | Sub topic 1-3-c: Not only transmission opportunity loss, but also HARQ-ACK feedback postponement, the two impacts caused by UL gap will deteriorate the system performance. Especially for type 2 gap. |
| OPPO | Sub topic 1-3-a: performance gain over the current R16 baseline  Gain can be observed in higher throughput be get.  Sub topic 1-3-b: performance evaluation/testability/requirements  In our understanding, the conformance testing only need to guarantee that UE is violating emission during gap is enough. And there is no need to testing the gain of introducing gap, since it is quite different for different UE implementations, some gain big others small. Therefore, there is no meaning to test the gain that can be achieved, instead the gain is only used to justify the benefit of this gap. |
| Nokia | Sub topic 1-3-a: Not clear why PA calibration and transceiver calibration should be separated. Instead the joint UE requirements and test cases for PA and transceiver calibration should be considered.  Sub topic 1-3-b: Consider developing joint UE requirements and test cases for PA calibration and transceiver calibration.  Sub topic 1-3-c: In our view only one gap type (Type1) should be defined and all the use cases and UE requirements for UL gaps should use the same gap type. Otherwise, the network complexity increases even further. Additionally, PA calibration and transceiver calibration requirements and test cases should be considered jointly to avoid too many cases for the network to handle, which would increase network complexity further. |
| NTT DOCOMO | Sub topic 1-3-c:  For clarification, is it correct that type1 gap for transceiver calibration have no network scheduling constraint?   * Whether the gap can be scheduled for other UE?   Whether NW does not need to allocate the gap periodically? |
| vivo | Sub topic 1-3-b: Considering the transceiver calibration can improve the I/Q imbalance and LO leakage, the IBE also can be a metric.  Sub topic 1-3-c: Even though the type 1 gap does not need scheduled resources, it still constrains network scheduling to some extent, which may be affected by gap length and periodicity. |
| Intel | Sub topic 1-3-b:  To test the UL Tx power improvement, is the intention to take two measurements (one with the gap on and one with it off)? |
| Huawei, HiSilicon | * Sub topic 1-3-a: performance gain over the current R16 baseline   Without gNB assist LO cancellation, there is no performance impact on 256QAM demodulation based on 3.5% EVM assumption, if UE can calibrate itself RF circuit.  It can save the DC location reporting signalling overhead, with up to 65 000 different theoretical locations.  gNB does not need to cancel the LO for each UE based on different DC locations.   * Sub topic 1-3-b: performance evaluation/testability/requirements   Performance evaluation could be processed by IBE test, or Tx power improvement test.   * Sub topic 1-3-c: network impact   Gap type is type 1, it could also allocated to other UEs.  For periodic UL gap, the analysis is similar as for power management. For case without scheduling limitation, there is no network impact. Considering scheduling limited and the worst case that all UL gap could not schedule to other UEs, the UL loss depends on the gap ratio. However, under such scheduling limited case, uplink service does not require for full buffer transmission.  To further reduce the UL gap loss, we could only have the calibration before UL transmission and also meet the UL gap ratio assumed in the last meeting.  We could further study how to reduce the gap overhead. |

Sub topic 1-4: coherent UL MIMO calibration

* Sub topic 1-4-a: performance gain over the current R16 baseline
* Sub topic 1-4-b: performance evaluation/testability/requirements
* Sub topic 1-4-c: network impact

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-4-a:  Sub topic 1-4-b:  Sub topic 1-4-c:  ….  Others: |
| Verizon | Sub topic 1-4-a |
| Apple | Performance gain of coherent MIMO over non-coherent MIMO is well studied in 3GPP.  We see the benefit of enabling coherent UL MIMO in the field.   * More details on how the UL gap is used, whether it is type-1 or type-2 are needed. |
| T-Mobile USA | Performance gain of coherent MIMO over non-coherent MIMO is well studied in 3GPP. |
| ZTE | For coherent UL MIMO calibration usecase, which type of UL gap is suitable, and whether the assumption of 0.25% - 5% UL gap overhead is applicable, all of these questions should be firstly answered. |
| OPPO | The gain comparing coherent MIMO to non-coherent MIMO is understood, however, how much gain can be derived by each UE is different. There is no need to define requirements for the gain itself. |
| Nokia | Sub topic 1-4-a: Like noted in R4-2107267, simulation work in Rel-15 both in RAN1 and RAN4 show average performance gain between coherent codebook subset and non-coherent codebook subset. However, it has not been studied what would be the best metric for ensuring that these performance gains are obtained in practical UE implementation and how much gaps are needed to obtain significant gains.  Sub topic 1-4-b: In order to ensure that potential gains materialize in practice it is important to carefully study suitable metrics and how the requirement and test cases should be defined We believe that RAN1 could help RAN4 what would be the most suitable way of measuring performance improvement and how then to develop UE requirements and test cases use to ensure better performing UEs. |
| Huawei, HiSilicon | * Sub topic 1-3-a: performance gain over the current R16 baseline   In the current Rel15/16 spec, coherent UL MIMO RF requirements are defined only when following conditions are met in current TS 38.101-2 sub clause 6.4D.4:  - UE is not signaled with a change in number of SRS ports in SRS-config, or a change in PUSCH-config  - UE remains in DRX active time (UE does not enter DRX OFF time)  - No measurement gap occurs  - No instance of SRS transmission with the usage antenna switching occurs  - Active BWP remains the same  - EN-DC and CA configuration is not changed for the UE (UE is not configured or de-configured with PScell or SCell(s))  If a UE can meet corresponding relative phase and power imbalance RF requirement under above conditions by calibration, the UE and network performance gain is the actually gain for coherent UL MIMO, which is already studied in RAN1 and RAN4 by simulations, >30% TP gain is expected.   * Sub topic 1-3-b: performance evaluation/testability/requirements   This calibration can be easily evaluated by RF requirement test on relative phase error and power imbalance under switch/config change conditions happen.   * Sub topic 1-3-c: network impact   Actually, UE can calibrate during the real transmission when switching is happened between SRS and PUSCH. There is no network loss, but only has some limitation on DMRS position since DMRS should be placed after calibration. This aspect can be discussed in phase 2.  For the gap, coherence calibration does not need additional gap overhead, it just calibrate when there is a PUSCH transmission after SRS transmission. But in the gap, some configuration limitation is needed, e.g. DMRS.  In summary, in our understanding, there is no network impact on coherence calibration. |

Sub topic 1-5: can different UE capabilities be separately specified for different usage case and types of gap.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | For the PA/Transceiver/coherent UL MIMO calibration variants the periodicity and lengths for those gaps are not settled.  If they are found to be different, we might end up with many gap variants, maybe one for each calibration purpose. This will even further complicate scheduling and have a large impact on NW. |
| Apple | Since different requirement and test cases will be defined for different usage case, we think it is natural to define UE capability separately for different usage case and type of gap. |
| Qualcomm | They can be and should be. UE may support type 1 or type 2 or both and different testable performance gains can be defined for each type of gap. For example type 1 gap (active TX) improves peak EIRP and type 2 gap improves carrier leakage or reduces P-MPR. |
| Sony | * We would also like to understand how long each calibration gap would be? Do the duration of the calibration gap be the same for different usage cases? |
| OPPO | A unified gap is preferred for different use cases, since they are no different and is purely UE inside behavior is unnecessary to be known to the NW. |
| Nokia | In our view the detailed UE capabilities should be decided once the actual cases and requirements are clear. We see that some UE capabilities are needed on this area. In our view only one gap type should be defined. The amount of gaps needed may vary for different use cases based on needs and gains obtained. |
| NTT DOCOMO | Firstly, we need to decide which types of usage cases will be introduced. After that if each usage case need different requirements and NW behavior, we should distinguish them. |
| vivo | We prefer to specified the capabilities for different gap types, and whether it is necessary to specified capabilities for different usage cases needs more discussion. |
| Huawei,HiSilicon | We are OK to have different UE capabilities be separately specified. |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1-1: UE power/coverage enhancement** | *Tentative agreements: Based on the discussions and inputs from interested companies, phase I related study for UE power/coverage enhancement with body proximity sensing can be completed and Phase II work can start from RAN4#99e. Based on WID, the scope of phase II include*   * *Only type 1 gap is considered* * Specify the UL gap configuration(s)   + Gap overhead should be jointly decided with a good balance of the performance gains obtained in terms of P-MPR reduction.   + *Specify related interruption requirements if needed* * *Specify related UE capability*   + *FFS on mutual signalling method using one-bit RRC flag from BS(s) and capability from UE(s) for the UL gap feature.* * *Specify the related test case(s) and/or requirements, if feasible, to ensure that the performance gains are obtained from the introduction of UL gaps for proximity sensing*   + *FFS on the test methodology, metric and criteria with different UE implementations considered.*   *Option 1: Yes*  *Option 2: No*  *Recommendations for 2nd round:* |
| **Sub-topic#1-2: PA calibration enhancement** | *Tentative agreements: Based on the discussions and inputs from interested companies,*  *Option 1: Further study to enhance FR2 peak EIRP requirement*  *Option 2: deprioritize UL gap for PA calibration in R17* |
| **Sub topic 1-3: transceiver calibration** | *Tentative agreements: Based on the discussions and inputs from interested companies,*  *Option 1: Further study for IBE enhancement based on the assumption of type 1 gap.*  *Option 2: Phase I related study for transceiver calibration can be completed and Phase II work can start from RAN4#99e.*   * *Only type 1 gap is considered*   *Option 3: deprioritize UL gap for transceiver calibration in R17* |
| **Sub topic 1-4: coherent UL MIMO calibration** | *Tentative agreements: Based on the discussions and inputs from interested companies, it is proposed to further study the metric to ensure the performance gain, how gap overhead will impact the performance gain and the related testability in next meeting.*  *Option 1: Yes*  *Option 2: No* |
| **Sub topic 1-5: can different UE capabilities be separately specified for different usage case and types of gap.** | *Tentative agreements: Define UE capability separately for different use cases if more than 1 use cases are agreed and strive to unify the gap design for different use cases.*  *Option 1: Yes*  *Option 2: No* |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | WF on UL gap for FR2 | Apple |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

**Sub-topic#1-1: UE power/coverage enhancement**

*Tentative agreements: Based on the discussions and inputs from interested companies, phase I related study for UE power/coverage enhancement with body proximity sensing can be completed and Phase II work can start from RAN4#99e. Based on WID, the scope of phase II include*

* *Only type 1 gap is considered*
* Specify the UL gap configuration(s)
  + Gap overhead should be jointly decided with a good balance of the performance gains obtained in terms of P-MPR reduction.
  + *Specify related interruption requirements if needed*
* *Specify related UE capability*
  + *FFS on mutual signalling method using one-bit RRC flag from BS(s) and capability from UE(s) for the UL gap feature.*
* *Specify the related test case(s) and/or requirements, if feasible, to ensure that the performance gains are obtained from the introduction of UL gaps for proximity sensing*
  + *FFS on the test methodology, metric and criteria with different UE implementations considered.*

*Option 1: Yes*

*Option 2: No*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Option 1. The gain of reduce P-MPR have been shown enough through the simulation/analysis. We can further check the actual gain by specify the test case in phase II. |
| Apple | Option 1. RAN4 should conclude phase I in 98bis-e and move to phase II discussion in 99e.  ***On performance gain*** over current R16 baseline, it is agreed and captured in 98e WF R4-2103114.  ***On requirement and testability***: There are concerns raised by different companies:  Qualcomm: “We need to define conformance test cases to show the gain with and without UL gaps allocated to the UE that declares the support for this feature.”  Apple: Example test case is provided in R4-210849 can be the starting point.  Sony: “It is unclear how to trigger the proximate sensor during the compliance test as there is no body phantom or any surrounding object are involved in the measurement”.  Apple: Proximity sensor will be activated all the time when UL gap is activated, to constantly detect whether MPE is met. No body phantom is needed during the test. UE without UL gap activated will not be able to know whether there is a body nearby or not, therefore a conservative P-MPR will be applied to ensure MPE requirement. UE with UL gap activated can detect no target nearby, therefore no P-MPR is needed.  ZTE: “Conformance test cases should be defined to show the gain. If some gain verified, detailed requirement improvements should be discussed, but we think which means large workload.”  Apple: We agree test cases and requirement should be designed and finalized in Phase II. UE without UL gap activated will not be able to know whether there is a body nearby or not, therefore a conservative P-MPR will be applied to ensure MPE requirement. UE with UL gap activated can detect no target nearby, therefore no P-MPR is needed.  Oppo: “In our understanding, the conformance testing only need to guarantee that UE is violating emission during gap is enough. And there is no need to testing the gain of introducing gap, since it is quite different for different UE implementations, some gain big others small. Therefore, there is no meaning to test the gain that can be achieved, instead the gain is only used to justify the benefit of this gap.”  Apple: On the performance gain test cases and requirements, further discussion should happen considering different UE implementations, and final requirements should be discussed and agreed in RAN4.  NTT Docomo: “P-MPR value is not specified in RAN4 and it is up to UE implementation, so even if we test the difference of P-MPR value between with and without this UL gap, the baseline requirements, i.e., P-MPR without the UL gap is up to UE implementation. How can we confirm the improvement?”  Apple: We agree that in R16 it is up to UE implementation that proper P-MPR is applied to meet MPE requirement. The delta-EIRP shows the improvement of UL gap in R17 compared to R16 for the UE implementation. The test is UE implementation agnostic. We are open to further discussion for test case design in Phase II.  Intel: “Perhaps further discussion and clarification is needed. We are trying to understand the benefit of defining an additional test for this use case for delta EIRP when UL gap is on/off. This involves allowing the UE to take P-MPR during testing, having the proximity sensor on and taking measurements without a target. We know P-MPR will be decreased when there is no target, testing this is effectively testing how good the detector is during the gap (this number should be the same as having no gap and P-MPR set to zero, as the measurement is currently done). Beyond this, why do we need to capture the delta?  Unless there is an additional *concurrent* increase in EIRP from having the UL gap (other than the increase coming from reducing P-MPR to 0), this test may not be needed.”  Apple: When UL gap is OFF, UE will always assume there is a target nearby, so a conservative P-MPR is always used to ensure MPE requirement. This represents a R16 UE without proximity sensor. When UL gap is ON, UE can detect if there is no target nearby, then no P-MPR is needed to ensure MPE compliance. The delta-EIRP shows the performance gain of R17 UE with UL gap over R16 UE.  ***Network impact:*** Comments to 1st round email discussion:  Ericsson: “NW will be impacted given the 5% gap overhead”.  Apple: 5% gap overhead used as an upper bound in study phase. We can further discuss this when working on the gap configuration in Phase II.  Qualcomm: “Network impact shall be positive. In practice any improvement on UE output power is such.”  Apple: As presented in R4-2104849, overall positive gain is observed even in worst case scenario (3dB Tx power improvement with 5% UL overhead in DDDSU configuration). In best case scenario, up to 200% cell edge UE throughput gain is observed.  Sony: “It is also unclear if the calibration gap would be necessary in this case. As mentioned by some contributions, proximate sensors to detect users have been implemented in commercial phones that do not require any gap to perform the detection.”  Apple: Other sensors are implementation choices. UL gap does not restrict other implementation choices. Performance gain with proximity sensing using UL gap will be verified in 3GPP. Gains from other solution are not verifiable in 3GPP.  ZTE: “Not only transmission opportunity loss, but also HARQ-ACK feedback postponement, the two impacts caused by UL gap will deteriorate the system performance.”  Apple: The gap pattern design in phase II should strive to avoid introducing additional ACK/NACK delay.  Nokia: “UL gaps create constraints to the network scheduler and negative impact on throughput. The amount of gaps needed needs to be in a good balance with the performance gains obtained in terms of P-MPR reduction. For example, considering a frame structure DDDSU in FR2 numerology 3 (i.e. 120 kHz SCS), there are 4 UL slots in 2.5 ms, which yields a: 25 % UL throughput loss with 5% UL gap periodicity and 1.25 % UL throughput loss with a 0.25% UL gap periodicity”  Apple: 5% gap overhead used as an upper bound in study phase. We can further discuss this when working on the gap configuration in Phase II.  NTT Docomo: “In the paper, there seems two cases, one is no network scheduling constraint, and another is the case where the UL gap cannot be scheduled to any other UEs. This is a big difference. We wonder if it must be better to specify only the case of no network scheduling constraint, but is there any drawback? If there is a possibility of scheduling constraint and other negative effect, we would like to discuss introduction of the mutual signaling methods that we proposed.”  Apple: Since scheduling constraint in the real deployment is hard to model for performance analysis purpose, we took the best case and worst-case approach for network impact analysis. The assumption is just to simplify analysis, and network signaling can be further discussed in phase II. |
|  |  |

**Sub-topic#1-1a: On non-zero P-MPR assumption in UE power/coverage enhancement testing and requirement**

*New test(s) should be introduced to demonstrate sufficient performance gain of UL gap for UL power/coverage enhancement. In this case, non-zero P-MPR needs to be assumed for the test of performance gain compared to Rel-16 baseline as described in the WID.*

*Option 1: Yes*

*Option 2: No*

|  |  |
| --- | --- |
|  |  |
| OPPO | Option 2, no. In conformance testing the PMPR is always 0 (can be seen in 38101-1/2/3), is the intention here to make UE apply non 0 PMPR? We don’t think this is the correct way to go.  And it should be noticed that the PMRP is not only apply to SAR/MPE, but also to solve the unwanted emissions, self desens, etc. as described in the spec. |
| vivo | Option 1. Admittedly, there is no precedence to introduce non-zero P-MPR in conformance test requirements. However, it seems that there is no other way to verify performance gain introduced by this P-MPR reduction. This is not contradict with WID in our understanding. |
| Apple | Option 1. Non-zero P-MPR can be assumed for UL gap test case. |

## **Sub-topic#1-2: PA calibration enhancement**

*Tentative agreements: Based on the discussions and inputs from interested companies,*

*Option 1: Further study to enhance FR2 peak EIRP requirement*

*Option 2: deprioritize UL gap for PA calibration in R17*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 2.  Unclear of the target of this PA calibration enhancement, is the intention to introduce some requirements for the PA calibration gains derived by introducing the gap? The gains UE can get is expected to be quite different due to different PAs, calibrations, etc. Then no unified gain can be derived unless companies do the simulation or measurement campaigns, but is this desired by companies? |
| vivo | Option 2. Considering only this use case need type 2 gap which have more constrains on network and the performance gain also not clear, it may be better to focus on other use cases first. |
| Apple | Option 2. Since no new submission in R17 so far. We can follow R15 conclusion on this use case. |

**Sub topic 1-3: transceiver calibration**

*Tentative agreements: Based on the discussions and inputs from interested companies,*

*Option 1: Further study for IBE enhancement based on the assumption of type 1 gap.*

*Option 2: Phase I related study for transceiver calibration can be completed and Phase II work can start from RAN4#99e.*

* *Only type 1 gap is considered*

*Option 3: deprioritize UL gap for transceiver calibration in R17*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 3. Similar comment as PA calibration. |
| vivo | Option 1/3 is OK for us. |
| Apple | We are open to Option 1 and Option 2. We see Transceiver calibration can calibrate transceiver performance due to temperature variation, resulting in improved DL throughout and higher UL Tx power. |

**Sub topic 1-4: coherent UL MIMO calibration**

*Tentative agreements: Based on the discussions and inputs from interested companies, it is proposed to further study the metric to ensure the performance gain, how gap overhead will impact the performance gain and the related testability in next meeting.*

*Option 1: Yes*

*Option 2: No*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 2, no. Unclear of the target, is the final goal to define requirements for the gain? If it is then how to define the gain without simulation/measurement campaign? |
| vivo | Option 1. The performance gain has been shown in R15, and the gap type and overhead need further discussion. |
| Apple | Option 1. More details on how the UL gap is configured and used need to be clarified. |

**Sub topic 1-5: can different UE capabilities be separately specified for different usage case and types of gap.**

*Tentative agreements: Define UE capability separately for different use cases if more than 1 use cases are agreed and strive to unify the gap design for different use cases.*

*Option 1: Yes*

*Option 2: No*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | No strong view, but Option 2 (one capability) is more aligned with our understanding. |
| vivo | It is proposed to determine this issue during Phase II in which more details be discussed. Currently it seems still not quite clear in comparison of the two options. |
| Apple | Option 1. |

|  |  |
| --- | --- |
|  |  |
|  |  |
|  |  |
|  |  |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |